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Antepartum fetal heart rate testing and the post-term gestation

Yvonne S. Thornton, Sze-Ya Yeh, Roy H. Petrie

From the Sloane Hospital for Women and the Section of Perinatal Obstetrics of the Division of Perinatal Medicine of the College of Physicians and Surgeons, Columbia-Presbyterian Medical Center, New York, New York

1 Introduction

With the advent of continuous fetal heart rate monitoring, the obstetrician has been better able to assess the status of fetal well-being in normal as well as high risk pregnancies. Antepartum fetal heart rate testing (AFHRT) was first introduced by HAMMACHER [5, 6]. Subsequently, the test has been refined and popularized in the United States by several groups [13, 14].

It is well-known that the post-term fetus is subject to increased perinatal morbidity and mortality from fetal dysmaturity, fetal distress, meconium aspiration, congenital anomalies and macrosomia [3, 8, 9, 18]. Recent literature on AFHRT has demonstrated that the largest single high risk indication for the performance of an AFHRT is that of the post-term gestation [10, 15]. Because the post-term gestation comprises the largest population in these previous studies, we have attempted to isolate and examine this group of patients at increased risk for placental insufficiency. The purpose of this study is to evaluate the experience at the Columbia-Presbyterian Medical Center with AFHRT in the management of the post-term gestation.

2 Patients and procedures

The study group consisted of both ward and private patients from the Sloane Hospital for Women at the Columbia-Presbyterian Medical Center. These patients underwent AFHRT because of suspected post-term gestation. From 1974 through 1977, the contraction stress test was used alone. From 1977 through 1978 both the contraction stress test and the non-stress test were employed as methods for antepartum fetal surveillance. **Only those low-risk patients whose pregnancies had progressed beyond 42 weeks from the last menstrual period were included in the study.** The contraction stress test (CST) technique was performed as described by RAY [13], i.e., the observation of the fetal heart rate for late decelerations during three spontaneous or oxytocin induced contractions occurring in a ten minute interval. The non-stress test (NST) was performed as outlined by

Curriculum vitae

YVONNE S. THORNTON *was born in 1947 in New York, New York. She received her medical degree in 1973 from the College of Physicians and Surgeons of Columbia University in New York. She completed her residency in Obstetrics and Gynecology at The Roosevelt Hospital in New York. She has done independent research at The Rockefeller University in New York in hematology and endocrinology. In 1979, she completed a two-year fellowship in Maternal-Foetal Medicine at the Babies Hospital and The Sloane Hospital for Women, Columbia-Presbyterian Medical Center, New York. Her main research interests are antepartum fetal monitoring, fetal acid-base physiology and fetal pharmacology.*

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NOCHIMSON [10], i.e. the occurrence of at least four fetal movements in a 20 minute interval, each of which is associated with a fetal heart acceleration which lasts fifteen seconds with a maximum amplitude of at least fifteen beats per minute. All tests were performed by perinatal nurse specialists and interpreted by the same investigator (R.H.P.). Patients were entered in the AFHRT protocol on a voluntary basis, therefore some post-term patients were electively excluded from the protocol and were placed in the prospective control group (1974–1979). The neonate was evaluated for postmaturity by neonatologists and by the DUBOWITZ classification [2]. There were two control groups. The retrospective control group (Control group number 1) included those post-term patients who delivered in the five years preceding the study period (1969–1974). This control group did not have the benefit of AFHRT. The prospective control group (Control group number 2) included those post-term patients who did not receive AFHRT during the study period (1974–1979). **The prospective study group consisted of those post-term patients who received AFHRT between 1974–1979.**

Management of the post-term patients was as follows: 1) service patients at 41+ weeks of gestation, as derived from the last menstrual period or second trimester ultrasonography, were referred to the High Risk Clinic the following week. The private patients who were post-term were followed by their personal physicians, 2) in the High Risk Clinic when the patient was 42+ weeks, 24-hour urinary estriol levels were obtained weekly and if feasible, amnioscopy was performed. Those patients who chose to be in the study underwent AFHRT on a weekly basis, 3) the preceding management was generally followed on the private service, except when amniocentesis was performed by some practitioners in order to ascertain the presence or absence of meconium in a patient with an unfavorable cervix.

Management protocol of the patients receiving AFHRT included the following: 1) a negative test or a reactive test was repeated within one week, unless urinary estriol levels fell significantly, in which case the AFHRT was repeated more often or the patient was induced, 2) a suspicious or non-reactive test was repeated within 24 hours, 3) a patient with a suspicious or non-reactive test was further evaluated for fetal well-being, pulmonary maturity, cervical status with consideration for termination of pregnancy, 4) patients with a favorable BISHOP's score were induced, 5) the patient with a positive contraction stress test was examined and those with a favorable score underwent induction and the patients with an unfavorable BISHOP's score underwent caesarean section.

Outcome as judged by APGAR score, meconium staining, mode of delivery and perinatal loss were evaluated. The determination of meconium for clinical evaluation was made at the time of admission with amnioscopy or at the time of rupture of membranes. The test of statistical significance was the ordered Chi-square test with YATES' correction when applicable.

3 Results

In the interval 1969–1974, there was an annual average of 3,260 deliveries weighing greater than 2500 grams of which **445 were post-term gestation (2.7 percent). This group of patients made up control group number 1.** In the interval 1974–1979, there was an annual average of 2,545 deliveries of greater than 2500 grams of which 404 were post-term gestation (3.2 percent). Of the 404 patients in the 1974–1979 interval, **314 underwent AFHRT for post-term gestation. This group was the study group. Control group number 2 consisted of the 90 post-term patients in the 1974–1979 interval who did not receive AFHRT.** The private-ward ratio in the AFHRT group was 40/60, which also was the ratio for total private/ward patients who delivered in the Sloane Hospital for Women. AFHRT was performed 602 times on 314 patients. There were 300 CST alone, 180 NST alone and 61 NST with CST.

The perinatal outcome as it relates to 5 minute APGAR scores of 7 or greater, APGAR scores of less than 7, stillbirths and neonatal deaths are given for both control groups and the study group in Tab. I. Statistical analysis demonstrated that **there was a significant difference in perinatal mortality between the study group and the control group number 1 ($p < 0.01$).** There was also a

Tab. I. Perinatal outcome.

	APGAR score ⩾ 7 (5 min)	APGAR score < 7 (5 min)	Stillbirths	Neonatal deaths	Total
Control #1	387 (87.0%)	39 (8.8%)	9 (2.0%)	10 (2.2%)	445
Control #2	84 (93.3%)	4 (4.4%)	1 (1.1%)	1 (1.1%)	90
Study group	308 (98.1%)	4 (1.3%)	0	2* (0.6%)	314

* a) Complication of amniocentesis b) Extensive congenital anomalies

highly significant difference ($p < 0.01$) comparing the perinatal morbidity between control group number 1 and the study group. When the comparison was performed comparing the study group and control group number 2, there was a significant difference in perinatal morbidity ($p < 0.05$): however, there was no statistical difference between these two groups in perinatal mortality. Statistical analysis of control group number 1 and control group number 2 revealed no statistical differences in either perinatal mortality or perinatal morbidity.

Of the 314 study patients, 303 were allowed to labor. Sixtyseven of these 314 patients had an abnormal AFHRT. During the era prior to the use of the NST, 45 of these 67 patients had an abnormal CST: 3 patients with a positive test underwent caesarean section because of an uninducible cervix and 42 patients had a suspicious test of which 26 had a vaginal delivery (13 had spontaneous onset of labor and 13 were induced) and 16 underwent caesarean section for the following indications: 4 for cephalopelvic disproportion, 9 for fetal distress, 1 developed severe pre-eclampsia with an unfavorable cervix and 2 had thick meconium with low BISHOP's scores. Following the adoption of the NST, there were 22 patients with a non-reactive NST and a suspicious CST: 16 delivered vaginally (11 had spontaneous onset of labor and 5 were induced) and 6 underwent caesarean section for the following indications: 3 for cephalopelvic disproportion, 2 for fetal distress and 1 had thick meconium with a low BISHOP's score. Of the 67 patients who had an abnormal AFHRT, 42 percent had meconium. Meconium was present in only 21.5 percent of the patients with normal AFHRT. This difference was statistically significant ($p < 0.001$). The complete data are given in Tab. II.

Of the 314 study patients, 95 were delivered by caesarean section. When the group of patients with abnormal AFHRT were compared to the group with normal AFHRT, there was no statistically significant difference in the percent of patients delivered by caesarean section in each group.

Using the DUBOWITZ score as a marker for the post-term gestation, abnormal and normal AFHRT results were compared. Of those babies with a normal AFHRT, 95 of 247 infants were classified as post-term. Of those babies with abnormal AFHRT, 37 of 67 were classified as post-term ($p < 0.05$). There were three instances of positive CST. All underwent caesarean section, as previously mentioned and all three had the clinical findings and DUBOWITZ scores indicating post-term/postmaturity syndrome.

The intrapartum fetal heart rate tracings of the 303 patients who were allowed to labor were reviewed for the presence or absence of moderate or severe variable decelerations during labor. The presence of variable decelerations during the first stage of labor was compared to the abnormal and normal AFHRT tracings. It was found that 57 of 247 patients (23.1 percent) with normal AFHRT had variable decelerations during labor. Thirty-six of 56 patients (64.3 percent) with abnormal AFHRT had variable decelerations during labor.

Tab. II. Meconium possage (314 patients).

	No meconium	With meconium	
Normal APFHRT	194	53 (21.5%)	247
Abnormal APFHRT	39	28 (41.8%)	67

$X^2 = 11.38$ $p < 0.001$

This difference was highly significant ($p < 0.001$). Approximately one-third to one-half of the patients in control group number 1 received intrapartum electronic fetal heart rate monitoring, most in the latter years of the five year period (1969–1974). In the prospective control group number 2, consisting of 90 patients, 83 were allowed to labor. Eighty-two had intrapartum electronic fetal heart rate monitoring; the stillbirth was not monitored. Of these 82 patients, 27 had evidence of moderate to severe variable decelerations (32.9 percent).

Inasmuch as the last menstrual period is the major source from which the estimated date of confinement is derived, the patients in the study group were divided into nine categories, according to the length of gestation. The shortest gestation was 42 to 43 weeks and the longest gestation was 48 to 49 weeks. The groups were further categorized into the trimester when they were first seen and evaluated. The findings indicated that 122 (38.9 percent) were first seen in the first trimester, 127 (40.4 percent) were first seen in the second trimester and 65 (20.7 percent) were first seen in the third trimester. Three patients whose pregnancies had progressed to 48–49 weeks, by their last menstrual period, were seen initially at 40 weeks of gestation and were followed with AFHRT for 8–9 weeks without any perinatal morbidity or mortality. The physical findings and DUBOWITZ scores indicated that these three infants were postmature. The data also showed that there was no correlation between an abnormal AFHRT and the increase in length of gestation.

There were two neonatal deaths in the study group. The first was attributed to an inadvertent laceration o the umbilical cord during amniocentesis. This patient had three suspicious contraction stress tests. The second death was due to a large diaphragmatic hernia of BOCHDALEK and bilateral pulmonary hypoplasia. This patient had a reactive non-stress test and had no evidence of variable decelerations or other signs of fetal distress during labor.

4 Discussion

Perinatal loss in pregnancies with evidence of placental insufficiency, as seen in the post-term gestation, is estimated in some studies to be three times normal [16, 18]. In this study, the significant increase in the occurrence of moderate to severe variable decelerations could be attributed to the decrease in the amount of amniotic fluid as well as the decrease in the fluid content of WHARTON's jelly in the cord. These changes, which are associated with the prolonged pregnancy, may explain the increase of umbilical cord compression in these patients.

An earlier report [7] describes the lack of correlation among post-maturity, abnormal AFHRT and meconium. Contrary to this study, **our results have demonstrated that there is a definite correlation among post-maturity, abnormal AFHRT and the presence of meconium in the post-term gestation.**

In this ten-year study, the two control groups were designed to eliminate any differences in the perinatal morbidity and mortality based solely on the technical improvement of neonatal resuscitation and neonatal intensive care. As seen in the results, there was still a significant difference in perinatal morbidity when the study group was compared with its internal control (Control group number 2).

FREEMAN [4] reported a high false positive rate for the contraction stress test, approaching 25 percent. Other studies have placed the false positive CST rateas high as 45 percent [12]. Few investigators have examined the false positive rate of the non-stress test, i.e., a non-reactive non-stress test with a subsequent negative contraction stress test. **This study**, agreeing with those published reports [17], **demonstrated a false positive rate for the non-stress test of 27.4 percent with a false negative rate of 0.6 percent.** Despite its high false positive rate, the non-stress test in conjunction with the contraction stress test was a reliable indicator for fetal compromise in the post-term gestation.

In the study group, when the patients were not inducible, confidence in AFHRT enabled these patients to continue their pregnancies up to 48 and 49 weeks without any increase in perinatal morbidity or mortality.

The relationship of abnormal AFHRT findings (variable decelerations) and the presence of variable decelerations on the fetal heart rate

tracing during labor may be of some prognostic value for the potential of cord problems. These findings support the work of BRUCE [1] and O'LEARY [11], which demonstrated the importance of AFHRT changes in caring for the post-term fetus during labor.

These data clearly demonstrate that AFHRT is a reliable surveillance system for the post-term gestation and that it has demonstrated a significant lowering of perinatal morbidity and perinatal mortality in the study group.

Obstetricians are all too familiar with the patient who presents late in her pregnancy with an uncertain last menstrual period and is two weeks beyond her estimated date of confinement. This dilemma poses a multitude of problems which may have far-reaching consequences for the fetus and neonate. In the final analysis, one must either temporize and await the onset of spontaneous labor or intervene and terminate the pregnancy for fear of increased perinatal morbidity and mortality.

With AFHRT, there is a rapid and practical method for assessing placental function and fetal well-being, permitting accurate selection of a small group of infants for whom further prolongation of intrauterine life would be disastrous. The results of this study have shown that AFHRT has a significant impact on decreasing perinatal morbidity and mortality associated with the post-term gestation.

Summary

This study has examined the role of antepartum fetal heart rate testing (AFHRT) in the management and outcome of the post-term gestation It spanned a ten year period from 1969 to 1979 and was conducted at the Sloane Hospital for Women at the Columbia-Presbyterian Medical Center in New York.

A study group was composed of 314 patients at 42+ weeks gestation who were managed with AFHRT. There were two control groups. Control group number one included those post-term patients delivered in the five years preceding our study period (1969–1974). This group did not have the benefit of AFHRT. Control group number two included those post-term patients who did not receive AFHRT during the study period (1974–1979). In addition to the AFHRT, adjunctive testing included 24-hour urinary estriol, ultrasonographic B scan, amnioscopy and amniocentesis, when indicated. Patients were entered into the AFHRT protocol on a voluntary basis.

Statistical analysis demonstrated a significant difference in perinatal morbidity and mortality between the study group and control group number one. There was a statistically significant difference in the perinatal morbidity between the study group and control group number two. Patients with abnormal AFHRT had a statistically significant increase in the incidence of intrapartum variable decelerations, meconium and the post-term/postmaturity syndrome. Three patients whose pregnancies had progressed to 48–49 weeks, by their last menstrual period, were seen initially at 40 weeks gestation and were followed with AFHRT for 8–9 weeks without any perinatal morbidity or mortality. The physical findings and the DUBOWITZ scores indicated that these three infants were postmature.

There were two neonatal deaths in the study group. The first was attributed to an inadvertent laceration of the umbilical cord during amniocentesis. The second death was due to a large diaphragmatic hernia of BOCHDALEK and bilateral pulmonary hypoplasia.

This study also demonstrated a false positive rate for the nonstress test of 27.4 percent with a false negative rate of 0.6 percent. Despite its high false positive rate, the nonstress test in conjunction with the contraction stress test was a reliable indicator for fetal compromise in the post-term gestation.

Suspected postmaturity continues to be a problem for the clinician. One must either temporize and await the onset of spontaneous labor or intervene and terminate the pregnancy for fear of increased perinatal morbidity and mortality.

With AFHRT, there is an accurate selection of a small group of infants for whom further prolongation in intrauterine life could be disastrous. The results of this study have shown that AFHRT has a significant impact on decreasing the perinatal morbidity and mortality associated with the post-term gestation.

Keywords: Antepartum fetal heart rate testing, contraction stress test, non-stress test, perinatal morbidity, perinatal mortality, post-term gestation.

Zusammenfassung

Antepartale fetale Herzfrequenzmessung bei übertragener Schwangerschaft

In unserer Studie untersuchten wir die Relevanz der antepartalen Herzfrequenzmessung für die Schwangerschaftsüberwachung und -beendigung bei Übertragung. Die Untersuchungen umfassen einen Zeitraum von 10 Jahren zwischen 1969 und 1979 und wurden am Sloane Hospital for Women am Columbia-Presbyterian Medical Center in New York durchgeführt.

In der Untersuchungsgruppe waren 314 Patientinnen ab der 42. SSW., bei denen die antepartale fetale Herzfrequenzmessung durchgeführt wurde. Daneben gab es zwei Kontrollgruppen: Kontrollgruppe 1 umfaßte jene Patientinnen, die nach übertragener Schwangerschaft zwischen 1969 und 1974 entbunden haben; in der Kontrollgruppe 2 waren Patientinnen aus dem Zeitraum 1974–79, bei denen ebenfalls keine Herzfrequenzmessung erfolgte. Bei entsprechender Indikation wurden in der Untersuchungsgruppe zusätzlich zur Herzfrequenzmessung weitere Tests durchgeführt wie z.B. Östriolausscheidung im 24-h-Urin, Ultraschallmessungen, Amnioskopie und Amniozentese. Alle Patientinnen unterzogen sich unserem Testprogramm auf freiwilliger Basis.

Die statistische Analyse ergab einen signifikanten Unterschied hinsichtlich der perinatalen Morbidität und Mortalität zwischen der Untersuchungsgruppe und der Kontrollgruppe 1, während der Unterschied zwischen der Untersuchungsgruppe und der Kontrollgruppe 2 nur hinsichtlich der perinatalen Morbidität statistisch signifikant war. Ergab die antepartale Herzfrequenzmessung pathologische Befunde, so traten intrapartale variable Dezelerationen, mekoniumhaltiges Fruchtwasser und Übertragungssyndrome signifikant häufiger auf. Bei 3 Patientinnen, die laut letzter Regel in der 48.–49. Woche waren und seit der 40. SSW. überwacht wurden, gab es in der perinatalen Phase keine Komplikationen. Nach der körperlichen Untersuchung und dem DUBOWITZ-Score wurden diese Kinder als postmatur eingestuft.

In der Untersuchungsgruppe traten 2 neonatale Todesfälle auf. In einem Fall war es während einer Amniozentese zur Verletzung der Nabelschnur gekommen; das zweite tote Kind hatte große Bochdalek'sche Hernien und eine bilaterale Pulmonalhypoplasie.

Die Studie ergab weiter, daß der Test ohne Belastung in 27,4% falsch positiv war gegenüber einer falsch negativen Rate von 0,6%. Trotz dieser hohen Rate an falsch positiven Ergebnissen war der Test ohne Belastung in Zusammenhang mit Kontraktionsauslösungen ein verläßlicher Indikator für die fetale Gefährdung bei Übertragung.

Der Verdacht auf Übertragung stellt weiterhin ein Problem für den Kliniker dar. Es gilt einerseits den Beginn spontaner Wehen abzuwarten und andererseits zum richtigen Zeitpunkt zu intervenieren und die Schwangerschaft zu beenden, um so eine erhöhte perinatale Morbidität und Mortalität abzuwenden.

Mit der antepartalen fetalen Herzfrequenzmessung ist es möglich, die kleine Gruppe von Kindern zu selektionieren, für die eine weitere Verlängerung des intrauterinen Lebens verhängnisvoll sein könnte. Unsere Ergebnisse zeigen, daß diese Methode einen bedeutsamen Beitrag zur Herabsetzung der mit Übertragung einhergehenden perinatalen Risiken leistet.

Schlüsselwörter: Antepartale fetale Herzfrequenzmessung, Kontraktionsbelastungstest, Non-stress-Test, perinatale Morbidität, perinatale Mortalität, übertragene Schwangerschaft.

Résumé

Contrôle du rythme cardiaque foetal pendant la grossesse et grossesses prolongées

Dans ce travail les auteurs ont étudié le rôle du controle du rythme cardiaque foetal (RCFC) pur la prise en charge et le devenir des grossesses prolongées. L'étude porte sur une décennie, de 1969 à 1979, et a été effectuée au département féminin Sloane du centre médical Columbia-Presbyterian de New-York.

314 patientes enceintes de 42 semaines ou plus et surveillées par RCFC ont constitue le groupe étudié. Deux groupes témoins ont été établis. Dans le premier sont incluses les patientes ayant accouché après terme pendant les 5 années précédant le début de l'étude (1969–1974). Ces patientes n'ont pas bénéficié du RCFC. Le deuxième groupe témoin comprend les patientes ayant accouché après terme mais sans avoir eu de RCFC pendant la période de l'étude (1974–1979). En plus du RCFC, d'autres examens ont été effectués lorsqu'ils étaient indiqués, dosage de l'estriol urinaire des 24 heures, échographie, amnioscopie, et amniocentèse. Le volontariat était à la base du protocole RCFC pour les patientes incluses.

L'analyse statistique met en évidence une différence dignificative pour la morbidité et la mortalité périnatales entre le groupe étudié et le groupe n^0 1. La différence est statistiquement significative sur la morbidité périnatale entre le groupe étudié et le groupe n^0 2. Les patientes présentant un RCFC anormal ont une augmentation significative de la fréquence des décélérations variables en cours de travail, de la présence de méconium et du syndrome post-terme/postmaturité. Trois patientes dont les grossesses se sont poursuivies jusqu'à 48–49 semaines, comptées à partir des dernières règles, ont été vues pour la première fois à 40 semaines et ont été suivies avec RCFC pendant 8 à 9 semaines sans morbidité ou mortalité périnatales. Les données cliniques et les scores de DUBOWITZ confirment que ces trois enfants étaient postmatures.

Deux morts néonatales ont été observées dans le groupe étudié. La première a été imputée à une lésion malencontreuse du cordon ombilical lors de l'amniocentèse. La seconde était en rapport avec une énorme hernie diaphragmatique de BOCHDALEK et avec une hypoplasie pulmonaire bilatérale.

Cette étude a aussi mis en évidence 27,4 pour-cent de faux positifs du nonstress test et 0,6 pour-cent de faux négatifs. Malgré la forte fréquence de faux positifs, le nonstress test couplé au test au syntocinon représente un indicateur fiable de l'état foetal au cours des grossesses prolongées. La suspicion de postmaturité reste un problème pour les cliniciens. Les uns temporisent et attendent le déclenchement spontané du travail, les autres sont actifs et interrompent la grossesse par crainte d'augmenter la morbidité et la mortalité périnatales.

Le RCFC permet la sélection réelle d'un petit groupe d'enfants pour lesquels la prolongation de la vie intra-utérine pourrait être désastreuse. Les résultats de cette étude ont montré que le RCFC a un impact significatif sur la diminution de la morbidité et de la mortalité périnatales qui sont le lot des grossesse prolongées.

Mots-clés: Etude du rythme cardiaque foetal pendant la grossesse, grossesses prolongées, morbidité périnatale, mortalité périnatale, non-stress test, test au syntocinon.

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Yvonne S. Thornton, M.D.
The New York Hospital – Cornell Medical Center
Department of Obstetrics-Gynecology
525 East 68th Street
New York, New York 10021